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Full Length Research

Effect of Pest and Pathogen infections on growth of *Syzygium cumini* (L.) Skeels

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Syzygium cumini (L.) Skeels commonly known as jamun is an important plant in traditional system of medicine for many diseases such as cardio- metabolic diseases as the fruits are rich in antioxidants and other phyto chemicals with curative and healing properties. Artificial regeneration of the plant species is the only solution for raising plantation of the species. Observations of present study are from an ongoing plantation program of _Syzygium cumini_ seedlings grown in root trainers maintained in poly house. Invasion of seedling with _Ceroplastes stellifer_ (CS), _Corynespora cassiicola_ (CC), _Penicillium_ sp. (PS) and _Phyllachora ambigua_ (PA) are identified. It is found that these pathogens interfere with the growth patterns of seedlings in the nursery. AGR based on plant height was highest in healthy plants from 0-30 days (0.377 ± 0.0024^{a}). AGR was least in plants infected with _Corynespora cassiicola_ from 30-60 days (0.004 ± 0.0011^{e}) and 60-90 days (0.005 ± 0.0009^{d}) of growth. Plants infested with _Phyllachora ambigua also showed very low AGR from 60-90 days (_0.008 ± 0.0011^{d}). Mean AGR from 0-90 days was highest in healthy plants and least in C. _cassiicola_ infected plants. Growth analysis based on mean height, AGR and LAI shows that retardation in growth rate of infected plants was in the order CC > PA > PS > CS. A better understanding of several leaf spotting fungi and pests, extend of infections caused by them is essential for the management of seedlings. Thoughtful handling of plants in the nursery is required in order to get rid of these pathogens during plantation programs.

Keyword: *Ceroplastes stellifer; Corynespora cassiicola; Penicillium sp.; Phyllachora ambigua.*

INTRODUCTION

Syzygium cumini (L.) Skeels belonging to Myrtaceae family is a tropical evergreen tree indigenous to India, Pakistan, Bangladesh, Nepal, Burma Sri Lanka and Indonesia. *S.cumini* is distributed widely in India, occurs in tropical and sub-tropical forest (Orwa, 2009). Fruits of *S. cumini* are traditionally used in Ayurveda and Unani for treatment of Diabetes mellitus (Fazal and Rezzak, 1986; Shukia et al., 2000). It is also used as therapeutic for kidney stone, liver disorders, bleeding piles, dysentery, jaundice, asthma and bronchitis (Kirtikar and Basu, 1975; Joshi, 2000). Oral consumption of fresh leaf juice is a remedy for stomach ache (Bhandary et al., 1995). Different parts of the plant were reported to have antioxidant, anti-inflammatory, neuropsycho-pharmacological, antimicrobial, anti-bacterial, anti-

HIV, antileishmanial and antifungal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, antifertility, anorexigenic, gastroprotective and anti-ulcerogenic and radioprotective activities (Sagrawat et al.,2006; Srivastava and Chandra, 2013).

S. cumini is a natural host of fungi such as *Diplodia variispora, Meliola cladotricha* and *Phyllachora ambigua* (Butler, 1997). Leaf spot and leaf blight disease were reported on *S. cumini*, caused by *Cylindrocladium quinqueseptatum* (*Calonectria quinqueseptata)* and *Cylindrocladium* sp. from India (Arushi and Mehrotra, 2000). *Pestalotiopsis* sp. isolated from naturally infected leaf samples collected from forest nursery of Mysore district, India was identified as the major pathogen causing leaf blight disease of *S. cumini* (Bhanumathi and Rai, 2007). Pathogenicity of *Chrysoporthe cubensis* were reported on *S. cumini* from China (Chen et al., 2010). Twenty-six species of insects belongs to the order Hemiptera were reported as pests on *S. cumini* from different parts of India (Kumar et al., 2010).

Production of healthy nursery seedlings is essential for plant propagation. Proper irrigation, substrate selection, temperature regulation and fertilization in green houses lead to good seedling growth but may also promote several biotic diseases (Landis, 1984, 1989). Fungal infection can cause high mortality in nurseries which is a serious problem in forest regeneration. Infected seedlings in nurseries when planted to forested areas may become a threat where the disease was not existed (Peterson and Smith, 1975). Insect pests in nursery cause serious damage to seedlings (Mathew 2005). Present study aimed to identify the pests and pathogen infections on *S. cumini* seedlings grown in nurseries and its effect on growth parameters.

MATERIALS and METHODS

Observations were made in *S. cumini* seedlings grown in root trainers in poly house located at Dr. T.C Joseph Memorial Botanical Garden, Department of Botany, Union Christian College, Aluva with coordinates 10°7'30"N and 76°20'3"E. Infected leaves were brought to the laboratory and infected regions were critically examined using dissection microscope for symptamatology. Tease mounts and scratch mounts were made for microscopic observations. Measurements of all microscopic structures were taken using micrometer.

Growth analysis was conducted in healthy plants (HP) and plants infected with *Corynespora cassiicola* (CC), *Penicillium. sp* (PS), *Phyllachora ambigua* (PA) and *Ceroplastes stellifer* (CS). Growth parameters studied were absolute growth rate (AGR) based on height and leaf area index (LAI) at 30, 60 and 90 days after germination.

The rate of increase in growth variable at time 't' is value of Absolute growth rate (AGR) based on plant height was calculated based on formula (Radford,1967).

$AGR = (h_2-h_1) / (t_2-t_1)$

h_1 and h_2 refer to the plant height (cm) at time t_1 and t_2, respectively. It was expressed in cm/ day.

Leaf area index was calculated using the formula (Watson, 1947);

$$LAI = \frac{\text{Total leaf area of plant (cm}^2\text{)}}{\text{Ground surface area (cm}^2\text{)}}$$

Ground surface area = surface area of cavity of root trainer in which seedlings were grown = 19.625 cm^2. Millimeter graph paper method was used to measure total leaf area

Statistical Analysis:

The data recorded was analysed statistically by one way ANOVA using SPSS version 16.0. Duncan's multiple range test were used to detect significant differences between the means at a significance level of $p<0.05$. Data were reported as Mean ± SE.

RESULTS and DISCUSSION

Leaves of *Syzygium cumini* seedlings exhibited infections by fungi and pests (Figure 1).

Corynespora cassiicola (Berk. and M.A. Curtis) Wei, (1950)

C. cassiicola belongs to phylum Ascomycota and family Corynesporascaceae. Affected leaves showed irregular amphigenous brown papery spots. Conidiophores were erect, septate, produce conidia singly. Conidia is subhyaline, 7-18 pseudoseptate, 50-200 µm in length and 10-20 µm in width with rounded apex and truncate base. *C. cassiicola* is a pathogenic fungus causes spots on stem, root, leaf and flower reported from over 70 countries in more than 280 host plants (Silva et al., 1995). *C. cassiicola* affects both young and old leaves and causes leaf fall. This may lead to a delay in maturation and even plant death (IRRDB, 2000). First symptoms of *C. cassiicola* appeared as small brown spots on leaves, it later increased in size. This was also reported in leaves of young lettuce plants hydroponically grown

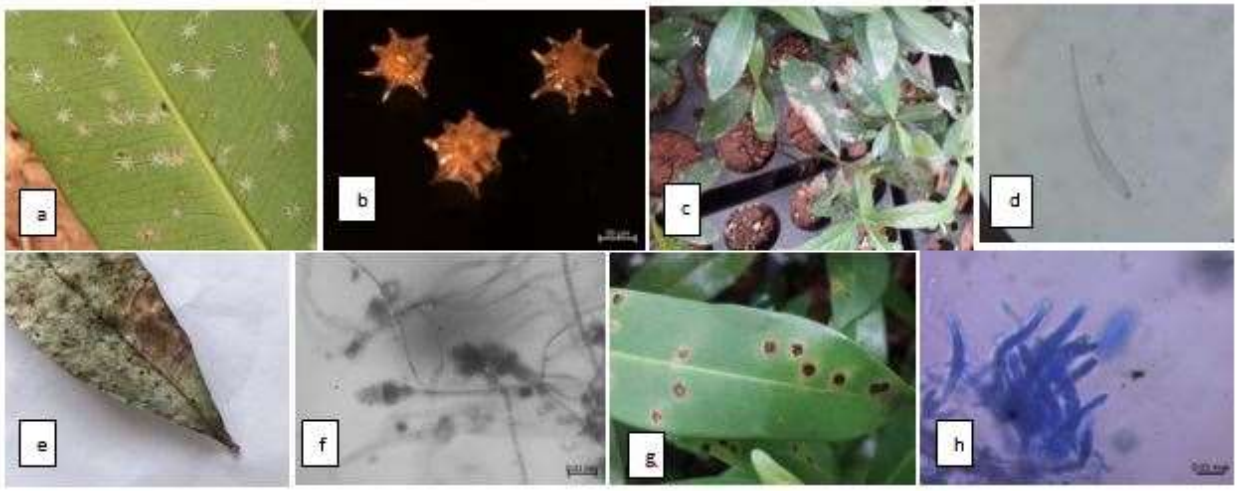

Figure1: Infections in *Syzihium cumini* seedlings: (a) and (b) *Ceroplastes stellifer (c) and (d) Corynespora cassiicola*, (e) and (f) *Penicillium. sp*, (g) and (h) *Phyllachora ambigua*

in glass house (Chairin et al., 2017). First record of *C. cassiicola* on *Hivea brasiliensis* was from Sierra Leone (Deighton, 1936). *C. cassiicola* was also reported on *H. brasiliensis* from several countries including India in seedling nurseries (Ramakrishnan and Pillai, 1961). *C. cassiicola* causes the *Corynespora* leaf fall (CLF) disease, characterized by necrotic lesions on the leaves and massive defoliation in susceptible cultivars (Deighton, 1936). In present study defoliation of leaves were not much prominent. *C. cassiicola* is responsible for diseases in a wide range of plants, mainly in tropical and subtropical areas or greenhouses (Farr and Rossman, 2016).

Phyllachora ambigua (Syd. and P.Syd.) Sydow 1915.

Phyllachora ambigua belongs to phylum Ascomycota and family Phyllachoraceae. *Phyllachora* species cause tar spot disease in leaves and occasionally in stems and roots of a wide range of host plants (Cannon, 1997). An average of 35-50 tar spots were found on each leaf. Infection spots are amphigenous, black, shining, minute and uniloculate. Perithicia isolated, flask shaped, innate, ostiolate, 175.5- 229.5 x 175.5-280 µm. Asci cylindrical, unitunicate, hyaline, octosporous, 62.7-79.2 x 6.6x7.25 µm. Paraphysis and periphysis are numerous and filiform. Ascospores are monostychous, hyaline and ovoid, 7.25- 9.9 x 6.6 µm. Tar spots were reported on living leaves of *Sizygium cumini* from Karwar, Mysore, india (Ananthanarayanan, 1964). Pathogenic infection by *Phyllachora ambigua* was reported on tropical fruit tree *Manilkara zapota* (Das, 1993).

Penicillium, Link (1809)

Pencillium belong to Phylum Ascomycota and family Trichomaceae. Metulae are enlarged cells arise from conidiophores. The metulae carry the flask-shaped phialides. Phialides form brush-like clusters on which conidia are formed in chain. Conidia are 3-4.5 µm diameters, round and unicellular. According to Pitt and Hocking (1988), *Pencillium* is a very large genus and so not easy to identify. The genus currently contains 354 accepted species (Visagie et al., 2014). *Pecillium* sp was isolated from stored leaves of *S. cumini* (Gupta et al., 2016). *Penicillium digitatum* is pathogenic and responsible for most of the postharvest losses of citrus fruit worldwide (Eckert and Brown, 1986). *P. allii, P. hirsutum* and *P. viridicatum*, are pathogenic species responsible for garlic crop losses (Gatica et al., 1984; Cavagnaro et al., 2005; Valdez et al., 2006).

Ceroplastes stellifer **(**Westwood, 1871**), (Syn: *Vinsonia stellifera*)**

Leaves of *Syzigium cumini* was infested with pest *Ceroplastes stellifer*. *C. stellifer* (stellate scale) was reported from different parts of the world including India. It has a wide range of host plants along with *S. cumini* (Hodges 2002). It belongs to a group of sap-sucking insects, classified under the order: Hemipteran Suborder: Sternorrhyncha, Infra order: Coccomorpha and Family: Coccidae. The genus

Table 1. Mean plant height (cm) at successive growth intervals of *Syzygium cumini*.

Infection	30 days	60 days	90 days	Mean
HP	11.32±0.071[a]	13.34±0.090[a]	14.92±0.099[a]	13.19
CC	7.31±0.081[e]	7.42±0.054[e]	7.58±0.087[e]	7.44
PS	10.02±0.087[c]	10.78±0.085[c]	11.36±0.075[c]	10.72
PA	8.42±0.078[d]	8.97±0.093[d]	9.21±0.064[d]	8.87
CS	11.05±0.072[b]	12.31±0.057[b]	13.16±0.083[b]	12.17
SE m±	0.324	0.441	0.539	0.0435
CD at 5%	0.225	0.229	0.243	0.232

Table 2. Absolute growth rate (AGR) cm/day based on plant height at successive growth intervals of *Syzygium cumini.*

Infection	30 days	60 days	90 days	Mean
HP	0.377±0.0024[a]	0.067±0.0010[a]	0.053±0.0005[a]	0.166
CC	0.244±0.0027[e]	0.004±0.0011[e]	0.005±0.0009[d]	0.084
PS	0.334±0.0029[c]	0.025±0.0004[c]	0.019±0.0008[c]	0.126
PA	0.281±0.0027[d]	0.018±0.0010[d]	0.008±0.0011[d]	0.102
CS	0.368±0.0022[b]	0.042±0.0007[b]	0.028±0.00012[b]	0.137
SE m±	0.0105	0.0045	0.0035	0.0062
CD at 5%	0.0158	0	0	0.0053

Ceroplastes contains 142 species (Hodgson and Peronti, 2012). *Ceroplastes stellifer* is a polyphagous soft scale insect that feeds on a variety of plants including many crops and ornamentals. The body of the insect was star shaped with center part of body slightly convex. Size of the adult insect varied from 3-5 mm across the rays. Each leaf was infested with an average of 40-60 pests on abaxial side. *C.stellifer* can occur in high densities on a single plant. As a result, it was considered a potential threat to several economically important plants (Hamon and Williams, 1984).

Growth Analysis

Various growth parameters on healthy and infected seedlings were recorded at regular intervals. There were significant differences between healthy and infected plants (Tables 1-3; Figures 2-4). Healthy plants showed significantly higher values in height, AGR and LAI and plants affected with *Corynespora cassiicola* showed least values. From analysed data it is evident that the plants infected with *Corynespora cassiicola* showed significant reduction in growth based on height and photosynthetic area as the fungus infected leaves did not show further growth and production of new leaves were significantly reduced.

Plants infected with *Pencillium* sp. exhibit decreased growth than uninfected plants but higher growth rate compared to the plant infected with *Phyllachora ambigua*. Plants infested with *Ceroplastes stellifer* did not show much reduction in growth compared to other infected plants. Growth analysis based on Mean height, AGR and LAI shows that reduction in plant growth of infected plants was in the order CC > PA > PS > CS.

Mean plant height obtained at various plant

Table 3. Leaf area index (LAI) in cm^2/ cm^2 at successive growth intervals of *Syzygium cumini.*

Infection	30 days	60 days	90 days	Mean
HP	1.71±0.042^a	2.98±0.082^a	3.75±0.052^a	2.81
CC	1.05±0.035^d	1.20±0.059^e	1.28±0.047^e	1.18
PS	1.39±0.058^b	1.86±0.048^c	2.20±0.055^c	1.82
PA	1.21±0.044^c	1.57±0.058^d	1.81±0.066^d	1.53
CS	1.60±0.036^a	2.47±0.066^b	3.10±0.077^b	2.39
SE m±	0.0524	0.1328	0.1825	0.1226
CD at 5%	0.1319	0.1866	0.1770	0.1652

Values are the means of four replicates. SE= Standard error; CD= Critical difference HP= Healthy plant; CC= *Corynespora cassiicol;* PS= *Penicillium. sp*; PA= *Phyllachora ambigua*; CS = *Ceroplastes stellifer.*

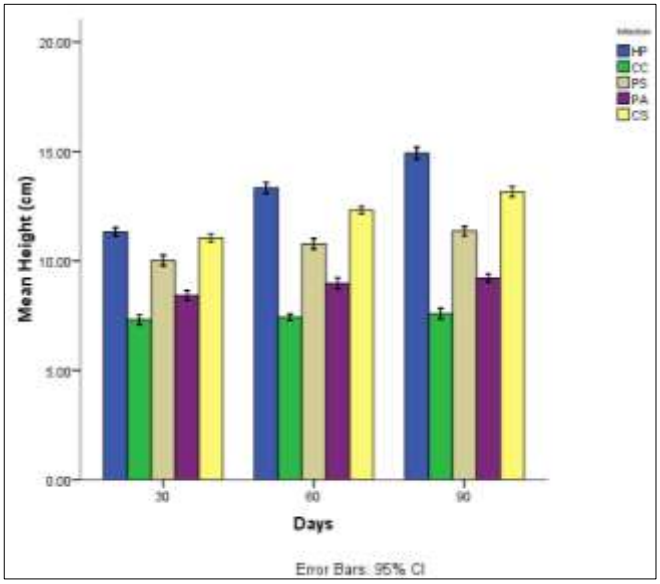

Figure 2. Mean plant height (cm) at successive growth intervals of *Syzygium cumini*

growth stages are presented in Table1, and which indicates that healthy plants recorded maximum height in 30, 60 and 90 days compared to infected plants. Least values were obtained in plants infected with *Corynespora cassiicola*. Mean height recorded in plants infested with pest *Ceroplastes stellifer were* better than other fungal infected plants. *Phyllachora ambigua and Pencillium* sp infected plants exhibit considerable reduction in growth with respect to plant height.

Data on absolute growth rate (AGR) based on plant height at various growth stages of plant are presented in Table 2 and Figure 3. AGR based on plant height was highest in healthy plants from 0-30 days (0.377±0.0024^a). AGR was least in plants infected with *Corynespora cassiicola* from 30-60 days (0.004±0.0011^e) and 60-90 days (0.005±0.0009^d) of growth. Plants infested with *Phyllachora ambigua* also showed very low AGR from 60-90 days *(*0.008±0.0011^d). Mean AGR from 0-

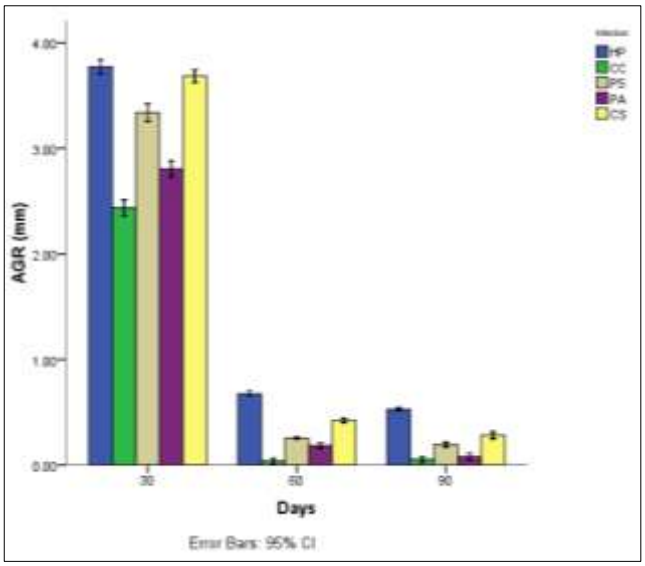

Figure 3. Absolute growth rate (AGR) cm/day based on plant height at successive growth intervals of *Syzygium cumini*

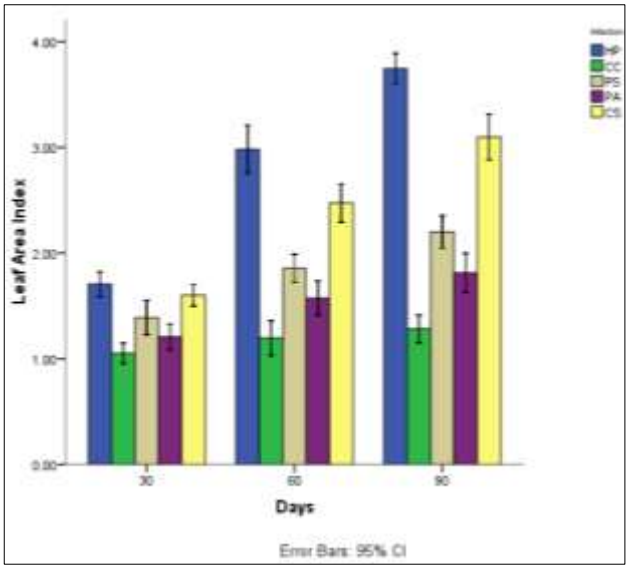

Figure 4. Leaf area index (LAI) in cm^2/ cm^2 at successive growth intervals of *Syzygium cumini*

90 days was highest in healthy plants and least in C. *cassiicola* infected plants. Mean values of leaf area index (LAI) at growth intervals are presented in Table 3. Higher LAI values were recorded in healthy plants. Plants infested with pest *Ceroplastes stellifer* revealed higher LAI value than other infected plants but lower than healthy plant. Among fungal infected plants, LAI was least reduced in plants infected with *Penicillium. sp* and highly reduced in plants infected with *Corynespora cassiicola.* Therefore, Hamon and Williams, (1984) rightly commented that they bring potential threat to several economically important

plants.

CONCLUSION

Leaves of *Syzygium cumini* seedlings grown in root trainers in poly-house were infested with *Corynespora cassiicola, Penicillium. sp*, *Phyllachora ambigua* and *Ceroplastes stellifer* were identified. Growth analysis based on height, AGR and LAI of infected plants revealed high retardation in growth. Reduction in growth rate was in the order CC > PA > PS > CS. Seedlings in nurseries are the chief source of planting stocks in forest nurseries. A better understanding of several leaf spotting fungi and pests, extend of infections caused by them is essential for the management of seedlings. Water management of poly-house may be considered, as the disease instance was severe during southeast monsoon season in the study area. Spacing of seedlings within the poly-house may manage to get better results.

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